

Patent Application
Docket No. UGR-100XD1
Serial No. 10/828,919

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Examiner : Sue Xu Liu
Art Unit : 1639
Applicants : Michael J. Adang, Laura M. Kasman
Serial No. : 10/828,919
Filed : April 20, 2004
For : Phage Display of a Biologically Active *Bacillus thuringiensis* Toxin

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313

DECLARATION OF MICHAEL J. ADANG, Ph.D. UNDER 37 CFR '1.132

Sir:

I, Michael J. Adang, Ph.D. hereby declare:

THAT my Curriculum Vitae is attached;

THAT I am a co-inventor on the subject application;

THAT I have reviewed the Office Action dated July 25, 2007, and the references cited therein;

And, being thus duly qualified, do further declare as follows:

Regarding the cited Marzari publication, Marzari actually teaches away from our invention. We demonstrated for the first time an active Cry toxin (fused with a phage protein) displayed on the surface of the phage. Marzari states on page 30, right column, for example, that Cloning of a large fragment corresponding to the activated [core] toxin caused slowed bacterial growth, but did not cause lysis unless the bacteria were also infected with a helper phage. We feel that this may arise from the insertion of a functional toxin pore molecule into the cell membrane following phage extrusion. The induction of toxicity is probably responsible for the lack of display observed. [emphasis added]

On page 31, left column, Marzari summarizes: "In conclusion, loop 2 and domain II [non-toxic fragments] appear promising for phage binding studies."

Thus, Marazari clearly teach away from using insecticidal fragments of *B.t. Cry* proteins.

In contrast, the insecticidal activity of the core toxin that is displayed according to our invention is a key component. For example, with the fragments described by Marzari, one could screen with the binding fragment for binding, but one could not then use the fragment to screen for insecticidal activity.

According to our invention, with phage-produced recombinants, one can make many recombinants that will allow easy production of Bt toxin proteins. Those with higher activity could be identified and sequenced to discover improved Bt genes. The core toxin molecule could also be screened for toxin binding and then immediately tested for improved biological activity by feeding the toxin-phage combination to larvae.

Regarding the cited Kasman et al. reference, Dr. Kasman, the first listed co-author on the publication, was a postdoctoral associate in my laboratory. Dr. Kasman came to my laboratory as an expert in phage display technology. She was the primary researcher on the project who designed and conducted the experiments. Dr. Kasman is an inventor on the patent application.

I conceived of the invention of using phage display to improve *Bacillus thuringiensis* toxins for enhanced insect control. I also assisted Dr. Kasman in directing the project and was a primary writer of the Kasman et al. paper. For these reasons, Dr. Kasman and I are listed as inventors of the subject B.t. phage display technology.

Dr. Stephen Gaczynski was a graduate student in my laboratory. He conducted binding experiments and was thus listed as an author on the cited Kasman et al. publication. However, he was not part of the conception of the invention. Dr. Gaczynski was thus not listed as an inventor on the subject patent application.

Dr. Rebecca McNall assisted Dr. Kasman in several experiments, including western blot analysis as I recall. For this work, she was listed as an author on the cited publication. However, she did not contribute to the conception, and is thus not listed as an inventor on the patent application.

Dr. Phil Youngman was a Professor of Genetics at the University of Georgia during the time the research was conducted. He is an expert in *Bacillus* genetics and a collaborator on a University

3

Docket No. UGR-100XD1
Serial No. 10/828,919

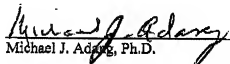
of Georgia technology grant that funded the project. Dr. Youngman was listed as a co-author on the Kasman et al. paper due to his collaboration on the grant proposal. However, he did not contribute to the conception of the invention and is not an inventor on the subject patent application.

Dr. Andrew Lukowiak was a graduate student in Dr. Youngman's laboratory. As I recall, he assisted with several DNA constructions. However, he was not involved in the conception of the invention and is not listed as an inventor on the patent application.

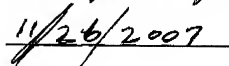
The undersigned declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or of any patent issuing thereon.

Further declarant sayeth naught.

Signed:


Michael J. Adang, Ph.D.

Date:



CURRICULUM VITAE

NAME: Michael J. Adang

DATE: November 26, 2007

EDUCATION

Indiana University	B.A.	1974
Washington State University	M.S.	1978
Washington State University	Ph.D.	1981

PROFESSIONAL EXPERIENCE

2003-present	Chief Scientific Officer, InsectiGen, Athens, GA.
2002-present	Director, Undergraduate Degree Program in Applied Biotechnology, University of Georgia, College of Agriculture and Environmental Sciences.
1996-present	Departments of Entomology, Biochemistry, and Molecular Biology, University of Georgia, Athens, Georgia. Professor.
1995-present	Department of Entomology, University of Georgia, Athens, Georgia. Professor.
1995-present	Department of Microbiology, University of Georgia, Athens, Georgia, Adjunct Professor.
1988-1995	Department of Entomology, University of Georgia, Athens, Georgia. Associate Professor.
1985-1988	Agrigenetics Advanced Science Company, Insect Resistance Program. Senior Research Scientist.
1982-1985	Agrigenetics Advanced Science Company, Insect Resistance Program. Research Scientist.
1982	Agrigenetics Advanced Research Division, Plant Molecular Biology. Postdoctoral Scientist.
1980-1981	Department of Bacteriology and Biochemistry, University of Idaho, Moscow, Idaho. Postdoctoral Fellow.

RESIDENT INSTRUCTION AND CONTINUING EDUCATION

A. Courses taught

BTEC 3000 (Ethics and Communication in Biotechnology, 2 credits), Co-instructor with Dr. Richard Hudson 2004-present
BCMB 4200/6200 (Biotechnology), Co-instructor with Dr. Michael Pierce 2000-present
BCMB 4130/6130 (Biotechnology), co-coordinator, 15 weeks, 1999
Instructor in Summer Workshop in Microbial Physiology (Sponsored by the University of Georgia and U.S. National Science Foundation), 1996
BIO 311 (Pilot for BIO 331) developed labs for 3 weeks, taught 3 weeks
BIO 299 (Biology Honors), 2 presentations, 1998
BIO 1108 (Biology Honors), 2 presentations per year, 1997-present
BIO 1104 (Principles of Biology), 5 weeks, 1995
BIO 1107 currently BIO1107(Biology Honors), 10 weeks, 1994, 1 presentation, 1997, 2 presentations per year, 1998-present.
ENTO 8570 (Molecular Entomology, 2 credits, 2 credits), team taught, 1994, 1998, 2000, 2005.
ENT 667 (Insect Pathogens; currently ENTO 6670), 10 weeks, 1993, 1995, 1997, 1999
BIO 103 (Principles of Biology), 1 week, 1993
ENT 615 (Insect Physiology) (Supervised laboratories), 1992; 2 lectures, 1993
FRS 804 (Forest Biotechnology) (Guest lecturer), 1992, 1994, 1996, 1998, 1999
ENT 900 (Special Problem), 1992
Insect Pathogens (Experimental Course), Spring 1991
Lecturer in course on "Applications of Genetic Engineering for the Improvement of Agriculture" at IDEA (Caracas, Venezuela). Sponsored by the Andean Development Corporation and the United Nations. October 8-11, 1990
Lecture in Insect Pest Management, 1990

SCHOLARLY ACTIVITIES

A. Publications

1. Chapters in books

- Adang, M.J. and Jurat-Fuentes, J.L. 2006. *Bacillus thuringiensis* Cry proteins. In J.N. All and M.F. Treacy, eds. Use and Management of Insecticides, Acaricides and Transgenic Crops. Entomological Society of America. Lanham, MD.
- Adang, M.J. 2004. [M638] Insect aminopeptidase N. In. A., and F. Woessner, eds. Handbook of Proteolytic Enzymes, 2nd Edition. Elsevier Science. Oxford.
- Jurat-Fuentes, J.L., Gould, F. and Adang, M.J. 2003. Dual resistance to *Bacillus thuringiensis* Cry1Ac and Cry2Aa toxin in *Heliothis virescens* suggests multiple mechanisms of resistance. Pest Management Newsletter. 12(2).
- Adang, M.J., Laprade, R., and Schwartz, J.L. 2002. *Bacillus thuringiensis* Cry1 protein mode of action: a functional relationship between toxin, receptors and the brush border membrane. 16-24. In Biotechnology of *Bacillus thuringiensis* and its environmental impact. Proceedings of the 4th Pacific Rim Conference. Ed. R.J. Akhurst, C.E. Beard, P.A. Hughes. CSIRO, Australia.
- Adang, M.J. 2001. Proteinas insecticidas de *Bacillus thuringiensis* en ingeniería de bacterias y plantas. pp. 345-360, In ed. Margarita Perea Dallos. Biotecnología Agrícola: Un enfoque hacia el mejoramiento de plantas. Asociación Colombiana de Estudios Vegetales in vitro. ACEVIA.
- Garczynski, S.F., Adang, M.J. 2000. Investigations of *Bacillus thuringiensis* Cry1 Toxin Receptor Structure and Function. In eds, J.-F. Charles, A. Delecluse and C. Nielsen-LeRoux. Entomopathogenic Bacteria: from laboratory to field application. Kluwer Academic Publishers, The Netherlands.
- Tabashnik, B.E., Groeters F.R., Finson, N., Liu, Y.-B., Johnson, M.W., Heckel, D.G., Luo, K., and Adang, M.J. 1996. Resistance to *Bacillus thuringiensis* in *Plutella xylostella*: The Moth Heard 'Round the World'. pp. 130-140, In: T. M. Brown (ed.), Molecular Genetics and Evolution of Pesticide Resistance, American Chemical Society Symposium Series 645. Washington D.C.
- Adang, M.J. 1995. Bacterial Pathogens of Insects. Included in background paper prepared for: U.S. Congress, Office of Technology Assessment. R. G. Van Driesche, T. G. Bellow, O. Minkenburg, M. Adang, B. Federici, C. McCoy, J. Maddox, H. Kaya, J. Lewis, R. Carde, and E. S. Krasur. Report on Biological Control Of Invertebrate Pests of Forestry and Agriculture. In: Biologically Based Technologies for Pest Control. Washington DC: U.S. Government Printing Office.
- Adang, M.J., Paskewitz, S.M., Garczynski, S.F., and Sangadala, S. 1995. Identification and functional characterization of the *Bacillus* CryIA(c) δ -endotoxin receptor in *Manduca sexta*. pp. 320-329, In: J. M. Clarke (ed.), Molecular Action of Insecticides on Ion Channels, American Chemical Society Symposium Series 591. Washington D.C.
- Boerma, H.R., All, J.N., Rowan, G.B., Parrott, W.A., Stewart, C.N., Adang, M.J., and Todd, J.W. 1994. Technologies for developing soybean varietal resistance to insects. Proceedings of the twenty-fourth soybean seed research conference. pp. 41-50.

1. Chapters in books (continued)

- Adang, M.J. and Miller, L.K. 1992. Genetic technology for resistance to insect pests. Background paper prepared for: U.S. Congress, Office of Technology assessment. In: A New Technological ERA for American Agriculture, OTA-F-474, Washington DC: U.S. Government Printing Office.
- Dean, D.H. and Adang, M.J. 1992. Protein engineering of *Bacillus thuringiensis* delta-endotoxins and genetic manipulation for plant protection. Chapter 16, pp.293-311, In: P. R. Shewry and S. Gutteridge (eds.), Plant protein engineering. University Press, Cambridge, UK.
- Adang, M.J. 1991. *Bacillus thuringiensis* insecticidal crystal proteins: Structure, action, and utilization. Chapter 1, pp. 3-24, In: K. Maramorosch (ed.), Biotechnology for Biological Control of Pests and Vectors. CRC Press, Boca Raton, FL.
- Adang, M.J., DeBoer, D., Endres, J., Firoozabady, E., Klein, J., Merlo, A., Merlo, D., Murray, E., Rashka, K., Stock, C. 1989. Manipulation of *Bacillus thuringiensis* genes for pest insect control. Proceedings of a conference: "Biotechnology, Biological Pesticides, and Novel Plant-Pest Resistance for Pest Insect Control." Ed. D. W. Roberts and R. R. Granados.
- Adang, M.J., Idler, K.F., and Rocheleau, T.A. 1987. Structural and antigenic relationships among three insecticidal crystal proteins of *Bacillus thuringiensis* subsp. *kurstaki*. In: K. Maramorosch (ed.), Biotechnology in Invertebrate Pathology and Cell Culture. Academic Press, Inc., NY.
- Adang, M.J., Firoozabady, E., Klein, J., DeBoer, D., Sekar, V., Kemp, J.D., Murray, E., Rocheleau, T.A., Rashka, K., Staffeld, G., Stock, C., Sutton, D., and Merlo, D.J. 1986. Expression of a *Bacillus thuringiensis* insecticidal protein gene in tobacco plants. In: Arntzen and C. Ryan (eds.), Molecular Strategies for Crop Protection. UCLA Symposia on Molecular and Cellular Biology, New Series, Volume 48. Alan R. Liss, Inc. New York, NY.
- Slighton, J.L., Adang, M.J., Ersland, D.R., Hoffman, L.M., Murray, M.J., and Hall, T.C. 1983. French bean storage protein gene family: Organization, nucleotide sequence and expression. In: P. Nagley, A. W. Linnane, W. J. Peacock, J. A. Pateman (eds.), Manipulation and Expression of Genes in Eukaryotes. Academic Press, pp. 123-142.
- Hall, T.C., Slighton, J.L., Ersland, D.R., Murray, M.G., Hoffman, L.M., Adang, M.J., Brown, J.W.S., Ma, Y., Mathews, J.A., Cramer, J.H., Barker, R.F., Sutton, D.W., and Kemp, J.D. 1983. Phaseolin: Nucleotide sequence explains molecular weight and charge heterogeneity of a small multigene family and also assists vector construction for gene expression in alien tissue. In: O. Ciferri, L. Dure (eds.), Structure and Function of Plant Genomes. Plenum Press, pp. 123-142.
- Miller, L.K., Miller, D.W., and Adang, M.J. 1983. An insect virus for genetic engineering: Developing baculovirus polyhedrin substitution vectors. In: P. F. Lurquin and A. Kleinhofs (eds.), Genetic Engineering in Eukaryotes. Plenum Publishing Corp.

2. Journal Articles

- Chen, J., Hua, G.H., Jurat-Fuentes, J.L., Abdullah, M.A., and Adang, M.J. 2007. Synergism of *Bacillus thuringiensis* toxins by a fragment of a toxin-binding cadherin. *Proc. Natl. Acad. Sci. U.S.A.* 104(35). 13901-13906.
- Jurat-Fuentes, J.L. and Adang, M.J. 2007. A proteomic approach to study Cry1Ac binding proteins and their alterations in *Heliothis virescens* larvae. *J. Invtbr. Pathol.* 95(3). 187-191.
- Krishnamoorthy, M., Jurat-Fuentes, J.L., McNall, R.J., Andacht, T. and Adang, M.J. 2007. Identification of novel Cry1Ac binding proteins in midgut membranes from *Heliothis virescens* using proteomic analyses. *Insect Biochem. Molec. Biol.* 37(3) 189-201.
- Karumbaiah, L., Oppert, B., Juan L. Jurat-Fuentes, J.-L., and Adang, M.J. 2007. Analysis of midgut proteinases from *Bacillus thuringiensis*- susceptible and -resistant *Heliothis virescens* (Lepidoptera: Noctuidae). *Comp. Physiol. Biochem. B. Biochem. Molec. Biol.* 146(1). 139-146.
- Jurat-Fuentes, J.L. and Adang, M.J. 2006. The *Heliothis virescens* cadherin protein expressed in *Drosophila* S2 cells functions as a receptor for *Bacillus thuringiensis* Cry1A but not Cry1Fa toxins. *Biochem.* 45: 9688-9695.
- Jurat-Fuentes, J.L. and Adang, M.J. 2006. Cry toxin mode of action in susceptible and resistant *Heliothis virescens* larvae. *J. Invertbr. Pathol.* 92: 166-171.
- Griffitts, J.S., Haslam, S.M., Yang, T., Garczynski, S.F., Mulloy, B., Morris, H., Cremer, P.S., Dell, A., Adang, M.J., Aroian, R.V. 2005. Glycolipids as receptors for *Bacillus thuringiensis* crystal toxin. *Science*, 307, 922-925.
- Chen, J., Brown, M.R., Hua, G., and Adang, M.J. 2005. Comparison of the localization of *Bacillus thuringiensis* Cry1A d-endotoxins and their binding proteins in larval midgut of tobacco hornworm, *Manduca sexta*. *Cell Tissue Res.* 321, 123-129.
- Jurat-Fuentes, J.L., Gahan, L.J., Gould, F.L., Heckel, D.G. and Adang, M.J. 2004. The HevCaLP protein mediates binding specificity of the Cry1A class of *Bacillus thuringiensis* toxins in *Heliothis virescens*. *Biochem.* 43, 14299-14305.
- Jurat-Fuentes, J.L. and Adang, M.J. 2004. Characterization of a Cry1Ac-receptor alkaline phosphatase in susceptible and resistant *Heliothis virescens* larvae. *Eur. J. Biochem.* 271, 3127-3135.
- Hua, G., Jurat-Fuentes, J.L. and Adang M.J. 2004. BtR1a extracellular cadherin repeat 12 mediates *Bacillus thuringiensis* Cry1Ab binding and cytotoxicity. *J. Biol. Chem.* 279, 28051-28056.
- Hua, G., Jurat-Fuentes, J.L., and Adang, M.J. 2004. Fluorescent-based assays establish *Manduca sexta* BtR1a cadherin as a receptor for multiple *Bacillus thuringiensis* Cry1A toxin in *Drosophila* S2 cells. *Insect Biochem. Molec. Biol.* 34, 193-202.
- Abdulla, M.F.A. Alzate, O., Mohammad, M., McNall, R.J., Adang, M.J., and Dean, D.H. 2003. Introduction of *Culex* toxicity into *Bacillus thuringiensis* Cry4Ba by protein engineering. *Appl. Environ. Microbiol.* 69, 5343-5353.
- Banks, D.J., and Adang, M.J. 2003. Cloning of a *Heliothis virescens* 110-kDa aminopeptidase N and expression in *Drosophila* S2 cells. *Insect Biochem. Molec. Biol.* 33, 409-508.
- Jurat-Fuentes, J.L., Gould, F.L., and Adang, M.J. 2003. Dual resistance to *Bacillus thuringiensis* Cry1Ac and Cry2Aa toxins in *Heliothis virescens* suggests multiple mechanisms of resistance. *Appl. Environ. Microbiol.* 69: 5898-5906.
- McNall, R. and Adang, M.J. 2003. Identification of novel *Bacillus thuringiensis* Cry1Ac binding proteins in *Manduca sexta* midgut through proteomic analysis. *Insect Biochem. Molec. Biol.* 33, 999-1010.
- Daniel, A., Sangadala, S., Dean, D.H., and Adang, M.J. 2002. Denaturation of either *Manduca sexta* aminopeptidase N or *Bacillus thuringiensis* Cry1A toxins exposes binding epitopes hidden under nondenaturing conditions. *Appl. Environ. Microbiol.* 68: 2106-2112.

2. Journal Articles (continued)

- Jurat-Fuentes, J.L., Gould, F.L., and Adang, M.J. 2002. Altered glycosylation of 63- and 68-kDa microvillar proteins in *Heliothis virescens* correlates with reduced Cry1 toxin binding, pore formation and increased resistance to *Bacillus thuringiensis* Cry1 toxins. *Appl. Environ. Microbiol.* 68: 5711-5717.
- Masson, L. Mazza, A., Sangadala, S., Adang, M.J., Brousseau, R. 2002. Polydispersity of *Bacillus thuringiensis* Cry1 toxins in solution and its effect on receptor binding kinetics. *Biochim. Biophys. Acta*, 1594: 266-275.
- Sangadala, S., Azadi, P., Carlson, D.H., and Adang, M.J. 2001. Carbohydrate analyses of *Manduca sexta* aminopeptidase N, co-purifying neutral lipids and their functional interactions with *Bacillus thuringiensis* Cry1Ac toxin. *Insect Biochem. Molec. Biol.* 32, 97-107.
- Banks, D. J., Jurat-Fuentes, J.L., Dean, D.H., and Adang, M.J. 2001. *Bacillus thuringiensis* Cry1Ac and Cry1Fa -endotoxin binding to a novel 110 kDa aminopeptidase in *Heliothis virescens* is not N-acetylgalactosamine mediated. *Insect Biochem. Molec. Biol.* 31, 909-918
- Daniel, A., Dean, D.H., and Adang, M.J. 2001. Analyses of the pore forming ability of *Bacillus thuringiensis* Cry1A mutant toxins using a light-scattering technique. *Pesticide Biochem. Physiol.* 70, 7-18.
- Lee, M.K., Jenkins, J.L., You, T.H., Curtiss, A., Son, J.J., Adang, M.J. and Dean, D.H. 2001. Mutations at the arginine residues in $\alpha 8$ loop of Cry1Ac *Bacillus thuringiensis* δ -endotoxin affect toxicity and binding to *Manduca sexta* and *Lymantria dispar* aminopeptidase N. *FEBS Letts.* 497: 108-112.
- Hua, G., Masson, L. Jurat-Fuentes, J.L., Schwab, G. and Adang, M.J. 2001. Binding analyses of *Bacillus thuringiensis* Cry δ -endotoxin using brush border membrane vesicles of *Ostrinia nubilalis*. *Appl. Environ. Microbiol.* 67, 872-879.
- Jurat-Fuentes, J.L. and Adang, M.J. 2001. Importance of Cry1 δ -endotoxin domain II loops for binding specificity in *Heliothis virescens* (L.). *Appl. Environ. Microbiol.* 67: 323-329.
- Jurat-Fuentes, J.L., Gould, F.L. and Adang, M.J. 2000. High levels of resistance and cross resistance to *Bacillus thuringiensis* Cry1 toxins in *Heliothis virescens* are due to reduced toxin binding and pore formation. *Resistant Pest Management.* 11: 23-24.
- Luo, K., McLachlin, J., Brown, M.R. and Adang, M.J. 1999. Expression of a glycosylphosphatidylinositol-linked *Manduca sexta* aminopeptidase N in insect cells. *Protein Expr. Purification* 17: 113-122.
- Luo, K., Banks, D., and Adang, M.J. 1999. Toxicity, binding, and permeability analyses of four *Bacillus thuringiensis* Cry 1 δ -endotoxins to brush border membrane vesicles of *Spodoptera exigua* and *Spodoptera frugiperda*. *Appl. Environ. Microbiol.*, 65: 457-464.
- Jenkins, J.L., Lee, M.K., Sangadala, S., Adang, M.J., Dean, D.H. 1999. Binding of *Bacillus thuringiensis* Cry1Ac toxin to *Manduca sexta* aminopeptidase-N receptor is not directly related to toxicity. *FEBS Letters*, 462: 373-376.
- deMaagd, R.A., Bakker, P.L., Masson, L., Adang, M.J., Sangadala, S., Stiekema, W., and Bosch, D. 1999. Domain III of the *Bacillus thuringiensis* delta-endotoxin Cry1Ac is involved in binding to *Manduca sexta* brush border membranes and its purified aminopeptidase N. *Molec. Microbiol.*, 31: 463-471.

2. Journal Articles (continued)

- Adams, T.T., Fiteaman, M.A., and Adang, M.J. 1999. *Bacillus thuringiensis* subsp. *kurstaki* spore production in batch culture using broiler litter extracts as complex media. *Bioresource Technology*. 67: 83-87.
- Ramachandran, S., Buntin, G.D., All, J.N., Tabashnik, B.E., Raymer, P.L., Adang, M.J., Pulliam, D.A., Stewart, Jr, C.N. 1998. Survival, development, and oviposition of resistant diamondback moth (Lepidoptera: Plutellidae) on transgenic canola producing a *Bacillus thuringiensis* toxin. 1998. *J. Econ. Entomol.* 91: 1239-1244.
- Kasman, L.A., Lukowiak, A.A., Garczynski, S.F., McNall, R.J., Youngman, P., and Adang, M.J. 1998. Phage display of a biologically active *Bacillus thuringiensis* toxin. *Appl. Environ. Microbiol.* 64: 2995-3003.
- Singsit, C., Adang, M. J., Lynch, R. E., Anderson, W. F., Wang, A., Cardineau, G., and Ozias-Akins, P. 1997. Expression of a *Bacillus thuringiensis cryIA(c)* gene in transgenic peanuts and its efficacy against lesser cornstalk borer. *Transgenic Research* 6: 169-176.
- Santos, M.O., Adang, M.J., All, J.N., Boerma, H.R., and Parrott, W. A. 1997. Testing transgenes for insect resistance using *Arabidopsis*. *Molecular Breeding* 3: 183-194.
- Schwartz, J.L., Lu, Y.-J., Sohnlein, P., Brousseau, R., Laprade, R., Masson, L., and Adang, M.J. 1997. Ion channels formed in planar lipid bilayers by *Bacillus thuringiensis* toxins in the presence of *Manduca sexta* midgut receptors. *FEBS Letters* 412: 270-276.
- Luo, K., Sangadala, S., Masson, L., Mazza, A., Brousseau, R., and Adang, M.J. 1997. The *Heliothis virescens* 170 kDa aminopeptidase function as "Receptor A" by mediating specific *Bacillus thuringiensis* CryIA δ -endotoxin binding and pore formation. *Insect Biochem. Molec. Biol.* 27: 735-743.
- Luo, K., Tabashnik, B.E., and Adang, M.J. 1997. Binding of *Bacillus thuringiensis* CryIAc toxin to aminopeptidase in susceptible and resistant *Plutella xylostella*. *Appl. Environ. Microbiol.* 63: 1024-1027.
- Lu, Y.-J. and Adang, M.J. 1996. Conversion of *Bacillus thuringiensis* CryIAc-binding aminopeptidase to a soluble form by endogenous phosphatidylinositol phospholipase C. *Insect Biochem. Mol. Biol.* 26: 33-40.
- Singsit, C., Adang, M.J., Lynch, R.E., Anderson, W.F., Wang, A., Cardineau, G., and Ozias-Akins, P. 1996. The expression of a *Bacillus thuringiensis cryIA(c)* gene in somatic embryos and peanut plants against lesser cornstalk borer. *Transgene Res.* 5: 1-8.
- Stewart Jr., C.N., Adang, M.J., All, J.N., Raymer, P.L., Ramachandran, S., and Parrott, W.A. 1996. Insect control and dosage effect in transgenic canola, *Brassica napus* L. (Brassicaceae), containing a synthetic *Bacillus thuringiensis cryIA(c)* gene. *Plant Physiol.* 112: 115-120.
- Stewart Jr., C.N., Adang, M.J., All, J.N., Boerma, H.R., Cardineau, G., Tucker, D., and Parrott, W.A. 1996. Genetic transformation, recovery and characterization of soybean (*Glycine max*) (L.) Merrill transgenic for a synthetic *Bacillus thuringiensis cryIA(c)* gene. *Plant Physiol.* 112: 121-129.
- Lu, Y.-J. and Adang, M.J. 1996. Distinguishing fall armyworm (Lepidoptera: Noctuidae) using a diagnostic marker. *Fla. Entomol.* 79: 48-55.
- Moar, W.J., Pustzai-Carey, H. Van Fassen, D. Bosch, R. Frutos, C. Rang, K. Luo, and Adang, M.J. 1995. Development of *Bacillus thuringiensis* CryIC resistance by *Spodoptera exigua* (Hubner) (Lepidoptera: Noctuidae). *Appl. Environ. Microbiol.* 61: 2086-2092.

- Garczynski, S.F., and Adang, M.J. 1995. *Bacillus thuringiensis* CryIA(c) δ -endotoxin binding aminopeptidase in the *Manduca sexta* midgut has a glycosyl-phosphatidyl inositol anchor. *Insect Biochem. Mol. Biol.* 25: 409-415.
- Masson, L., Lu, Y.-J., Mazza, A., Brousseau, R., and Adang, M.J. 1995. The CryIAC receptor purified from *Manduca sexta* displays multiple specificities. *J. Biol. Chem.* 270: 20309-20315.
- Luo, K., and Adang, M.J. 1994. Removal of adsorbed toxin fragments that modify *Bacillus thuringiensis* CryIC δ -endotoxin iodination and binding by sodium dodecyl sulfate treatment and renaturation. *Appl. Environ. Microbiol.* 60: 2905-2910.
- Parrott, W.A., All, J.N., Adang, M.J., Bailey, M.A., and Boerma, H.R. 1994. Evaluation of transgenic soybeans (*Glycine max* [L.] Merr.) containing a *Bacillus thuringiensis* var. *kurstaki* insecticidal gene. *In Vitro Cell. Dev. Biol.* 30P: 144-149.
- Sangadala, S., Walters, F., English, L.H., and Adang, M.J. 1994. *Manduca sexta* aminopeptidase and phosphatase enhance *Bacillus thuringiensis* insecticidal CryIA(c) toxin binding and $^{86}\text{Rb}^+$ - K^+ leakage *in vitro*. *J. Biol. Chem.* 269: 10088-10092.
- Tabashnik, B.E., Finson, N., Groeters, F.R., Moar, W.J., Johnson, M.W., Luo, K., and Adang, M.J. 1994. Reversal of resistance to *Bacillus thuringiensis*. Reversal of resistance to *Bacillus thuringiensis*. *Proc. Natl. Acad. Sci. U.S.A.* 91: 4120-4124.
- Lu, Y.-J., Kochert, G.D., Isenhour, D.J., and Adang, M.J. 1994. Molecular characterization of a strain-specific repeated DNA sequence in the fall armyworm *Spodoptera frugiperda* (Lepidoptera: Noctuidae). *Insect Mol. Biol.* 30(2): 123-130.
- Ozias-Akins, P., Schnall, J.A., Anderson, W.F., Singsit, C., Clemente, T. E., Adang, M.J., and Weissinger, A.K. 1993. Regeneration of transgenic peanut plants from stably transformed embryogenic callus. *Plant Science* 93: 185-194.
- Adang, M.J., Brody, M.S., Cardineau, G., Eagan, N., Roush, R.T., Shewmaker, C.K., Jones, A., Oakes, J.V., and McBride, K.E. 1993. The reconstruction and expression of a *Bacillus thuringiensis* cryIIIA gene in protoplasts and potato plants. *Plant Mol. Biol.* 21: 1131-1145.
- Lu, Y.-J., Adang, M.J., Isenhour, D.J., and Kochert, G.D. 1992. Restriction fragment length polymorphism analysis of genetic variation in the fall armyworm (*Lepidoptera*: Noctuidae). *Molecular Ecol.* 1: 199-208.
- Garczynski, S.F., Crim, J.W., and Adang, M.J. 1991. Identification of putative insect brush border membrane binding molecules specific to *Bacillus thuringiensis* delta-endotoxin by protein blot analysis. *Appl. Environ. Microbiol.* 57: 2816-2820.
- Murray, E., Stock, C., Eberle, M., Sekar, V., Rocheleau, T., and Adang, M.J. 1991. Analysis of unstable RNA transcripts of insecticidal protein genes of *Bacillus thuringiensis* in transgenic plants and electroporated protoplasts. *Plant Mol. Biol.* 16: 1035-1050.
- Stock, C., McGloughlin, T.J., Klein, J.A., and Adang, M.J. 1990. Expression of a *Bacillus thuringiensis* crystal protein gene in *Pseudomonas cepacia* 526. *Can. J. Microbiol.* 36: 879-884.
- Sekar, V., Thompson, D.V., Maroney, M.J., Bookland, R., and Adang, M.J. 1987. Molecular cloning and characterization of the insecticidal crystal protein gene of *Bacillus thuringiensis* var. *tenebrionis*. *Proc. Natl. Acad. Sci. USA* 84: 7036-7040.

2. Journal Articles (continued)

- Adang, M.J., Staver, M.J., Rocheleau, T.A., Leighton, J., Barker, R.F., and Thompson, D.V. 1985. Characterized full-length and truncated plasmid clones of the crystal protein of *Bacillus thuringiensis* subsp. *kurstaki* HD-73 and their toxicity to *Manduca sexta*. *Gene* 36: 289-300.
- Talbot, D.R., Adang, M.J., Slightom, J.L., and Hall, T.C. 1984. Size and organization of a multigene family encoding phaseolin, the major seed storage protein of *Phaseolus vulgaris* L. *Mol. Gen. Genet.* 198: 42-49.
- Miller, L.K., Adang, M.J., and Browne, D. 1983. Protein kinase activity associated with the extracellular and occluded forms of the baculovirus *Autographa californica* nuclear polyhedrosis virus. *J. Virol.* 46: 275-278.
- Adang, M.J. and Spence, K.D. 1983. Permeability of the peritrophic membrane of the Douglas fir tussock moth (*Orgyia pseudotsugata*). *Comp. Biochem. Physiol.* 75A: 233-238.
- Adang, M.J. and Miller, L.K. 1982. Molecular cloning of DNA complementary to mRNA of the baculovirus *Autographa californica* nuclear polyhedrosis virus: Location and gene products of RNA transcripts found late in infection. *J. Virol.* 44: 782-793.
- Adang, M.J. and Spence, K.D. 1982. Biochemical comparisons of the peritrophic membranes of the lepidopterans *Orgyia pseudotsugata* and *Manduca sexta*. *Comp. Biochem. Physiol.* 73B: 645-649.
- Adang, M.J. and Spence, K.D. 1981. Surface morphology of peritrophic membrane formation in the cabbage looper, *Trichoplusia ni*. *Cell Tissue Res.* 218: 141-147.
- Brandt, C.R., Adang, M.J., and Spence, K.D. 1978. The peritrophic membrane: Ultrastructural analysis and function as a mechanical barrier to microbial infection in *Orgyia pseudotsugata*. *J. Invert. Pathol.* 32: 12-24.

3. Bulletins or Reports

- Adang, M.J. 1998. Investigations of CryI toxin receptor structure and function. Pp. 320-323. *In: VIlth International Colloquium on Invertebrate Pathology and Microbial Control and IVth International Conference on Bacillus thuringiensis*. Proceedings. Sapporo, Japan.
- Adang, M.J., Sangadala, S., and Lu, Y.-J. 1994. Identification and functional-characterization of *Bacillus thuringiensis* CryIA(c) delta-endotoxin receptors. Abstracts of papers of the American Chemical Society. San Diego, CA. March 13 V207, P 178-Agro.
- Adang, M.J., Sangadala, S., Lu, Y.-J., Garczynski, S.F., and Luo, K. 1994. Molecular features of *Bacillus thuringiensis* CryI toxin receptors. pp. 43-47. *In: VIlth International Colloquium on Invertebrate Pathology and Microbial Control*. Proceedings Volume I. Montpellier, France.
- Adang, M.J., Paskewitz, S., and Garczynski, S.F. 1992. Characterization of insect brush border proteins specific to *Bacillus thuringiensis* insecticidal proteins by toxin and monoclonal antibody binding. Abstract for World Congress on Cell and Tissue Culture. *Invitro Cell. Devel. Biol.* 28: 49A.
- Parrott, W.A., Bailey, M.A., Adang, M.J., Boerma, H.R., and All, J.N. 1992. Introduction of a *Bacillus thuringiensis* var. *kurstaki* (Btk) gene into soybean. Fourth Biennial Conference on the Molecular and Cellular Biology of the Soybean. Ames, IA July 27-29, P 2.

4. Book Reviews

Adang, M.J. 1990. Book review of "Biotechnology for Crop Protection," for Entomological Society of America. Environ. Entomol. 19: 1903-1904.

5. Any other (popular articles)

Transgenic Plant Workshop: Final Report. 1990. Morris Levin and Marvin Rogul, Organizers. "Product Characterization" working group, M. Adang, chair. College Park, MD.

B. Creative contributions other than formal publications

Patents (U.S. Only) Issued

Adang, M.J. Methods and Materials for Identifying Novel Pesticide agents. 2006. U.S. Patent 7,011,975

Insect Resistant Plants. 2005. M.J. Adang and J.D. Kemp. U.S. Patent 6,943,282

Methods and materials for identifying novel pesticide agents. 2003. M.J. Adang and K. Luo. U.S. Patent 6,586,197 B1.

Insecticidal Protein Fragments. 2001. M.J. Adang. U.S. Patent 6,251,656 B1

Insecticidal Protein Fragments. 2001. M.J. Adang. U.S. Patent 6,229, 004 B1

Transgenic plants comprising a synthetic insecticidal crystal protein gene having a modified frequency of codon usage. 2000. M.J. Adang and E. Murray. U.S. Patent 6,013,523.

Insecticidal Protein Fragments. 2000. M.J. Adang. U.S. Patent 6,114,138

Synthetic insecticidal crystal protein gene having a modified frequency of codon usage. 2000. M.J. Adang and E. Murray. U.S. Patent 6,015,891.

Bacillus thuringiensis δ -endotoxin fragments. 1998. M.J. Adang. U.S. Patent No. 5,710,020.

Toxin active against lepidopteran insects 1996. US Patent 5,578,702.

Synthetic Insecticidal Crystal Protein Gene. 1996. M.J. Adang, T.R. Rocheleau, D. J. Merlo, and E. Murray. Status: U.S. Patent 5,567,862

Synthetic Insecticidal Crystal Protein Gene. 1996. M.J. Adang, T.R. Rocheleau, D. J. Merlo, and E. Murray. Status: U.S. Patent 5,567,600

Synthetic Insecticidal Crystal Protein Gene. 1995. M.J. Adang, T. R. Rocheleau, D.J. Merlo, and E. Murray. U.S. Patent 5,380,831

Biological control of insects using *Pseudomonas* strains transformed with *Bacillus thuringiensis* insect toxin gene 1993. C. Stock, T.J. McLoughlin, J.A. Klein, M.J. Adang U.S. Patent 5,229,292.

Patents, U.S. only, Published Applications

Peptides for Inhibiting Insects. 2005. M. J. Adang et al. U.S. Patent Publication 20050283857

Identification of toxin-binding protein involved in resistance to Cry1 toxins, and related screening methods. 2005. M. J. Adang et al. U.S. Patent Publication 20050064386.

Phage display of a biologically active B.T. toxin. 2004. M.J. Adang et al., U.S Patent publication. 20040254364.

Insecticidal protein fragments. 2002. M.J. Adang. U.S. Patent publication 20020048799

C. Grants received

- 4/01/2006-12/31/2006. InsectiGen. Stabilization of BtBooster for Enhanced Insect Control. \$50,000.
- 7/1/2005-12/31/2006. BtBooster optimization and formulation research. InsectiGen. \$50,000.
- 9/15/2004-9/14/2007. *Bacillus thuringiensis* toxin – *Heliothis* receptor interactions. M.J. Adang (P.I.), J.L. Jurat-Fuentes (co-P.I.). USDA-CSREES NRI. \$280,000
- 12/5/2003-6/30/2004. High throughput screening for identifying improved pore-forming toxins. Georgia Research Alliance Innovation Grant.\$50,000.
- 09/19/03-9/30/2008. Functional domains of *Bacillus thuringiensis* endotoxins: Examine the nature of mosquito midgut receptors. PHS-NIH DH. Dean (P.I.) and M. J. Adang (P.I.). Subcontract for \$778,433 through Ohio State University Research Foundation.
- 8/19/2003-8/1/2005. Role of the cadherin-like protein from *Lymantria dispar* as a Cry1A toxin receptor. USDA (Forest Service). \$30,000.
- 8/8/2003-8/8/2004. A high-throughput screen for identifying improved pore-forming toxins. InsectiGen. \$50,000.
- 10/1/02-9/30/05. US-Israel Binational Science Formation. Functional Genomics of *Bacillus thuringiensis* toxin action. \$75,000.
- 7/1/01-6/30/02. Bt toxin toxin mode-of-action studies vs *Helicoverpa zea* and Western corn rootworm; also *Photographus* toxin mode-of-action studies. DOW Agrosiences. \$98,250
- 7/1/98-extended to 8/31/02. Bt toxins against Budworms, Cornborers and rootworms. Mycogen Seeds. \$271,195.
- 9/15/97-8/31/2002. Functional domains of *Bacillus thuringiensis* endotoxins: Identification of sites on *Manduca sexta* aminopeptidase that interact with Cry1A toxins. PHS-NIH DH. Dean (P.I.) and M.J. Adang (P.I.). Subcontract for \$508,200 through Ohio State University Research Foundation.
- 9/1/97-8/31/99. *Bacillus thuringiensis* toxin-receptor interactions. USDA-CSRS. NRI. Award No. 97-35302-4548. \$150,000.
- 9/1/96-1/31/98. Bt toxins against budworms and rootworms. Mycogen Plant Sciences. \$120,000.
- 9/1/96-8/30/99. Genetic and Molecular Basis of Resistance to Bt in Diamondback Moth. USDA-CSRS. NRI. D.G. Heckel, B.E. Tabashnik, and M.J. Adang. Sub-contract No. 2 Total \$54,179. \$180,000.
- 9/1/95-8/31/97. Characterization of *Bacillus thuringiensis* receptor proteins USDA-CSRS. NRI. 95-37302-1803. \$120,000.
- 7/1/95-6/30/97. Selection of novel *Bacillus thuringiensis* toxin by receptor screening. UGA Biotechnology. M.J. Adang (P.I.) and P. Youngman (co-P.I.). \$34,000
- 1/1/95-12/31/95. Bt toxins against budworms and rootworms. Mycogen Plant Sciences. \$80,000.
- 9/1/94-8/31/99. Prokaryotic Diversity – An organismal Approach. NSF. W. Whitman (P.I.) and A.O. Summers (co-P.I.), M.J. Adang, Steering Committee Member and organizer of summer workshop on *Bacillus thuringiensis*. \$1,996,418.
- 7/1/94-6/30/95. Analysis of Bt toxin binding proteins in *Spodoptera*. Ecogen. \$24,000.
- 7/1/94-6/30/95. Characterization and modification of tomato spotted wilt virus glycoproteins. UGA Biotechnology. C.M. Deom (P.I.), C. Demski, A. Culbreath, and M. Adang. \$22,167.
- 1/1/94-12/31/94. Mycogen Plant Sciences. “Bt toxins against weevils”, \$110,000.
- 9/1/93-8/31/98. NIH. “Molecular Cell Biology of Parasites and Vectors”, R. Damian, Program Director, M.J. Adang, Steering Committee Member. \$715,939
- 9/1/93-8/31/94. USDA-CSRS, “Identification of *Bacillus thuringiensis* toxin receptors”, USDA-CSRS. 91-37302-6277, \$55,000.
- 7/1/92-6/30/94. United Soybean Board, “Engineering insect resistance in soybeans”. \$79,939.

7/1/92-6/30/94. UGA Biotechnology, "Characterization and modification of tomato spotted wilt virus glycoproteins". \$58,000)8/1/92-7/31/94. Ecogen, "Analysis of *Bt* toxin binding proteins in *Spodoptera*". \$53,000.
 9/1/92-8/31/94. USDA Competitive Grants Program, "Interactions of insect resistant genes in soybeans". \$100,000.
 1/1/92-12/31/92. Crop Genetics International, "Analysis of insecticidal proteins in a biopesticide". \$20,000.
 11/1/91-indefinite extension. Agrigenetics Co., "*Bt* strains toxic to Coleoptera. Analysis of *Bt* proteins in plants". \$140,000.
 9/1/91-8/31/93. CSRS/USDA Competitive Grants Program, "Identification of *Bt* receptor proteins". \$120,000.
 7/1/90-6/30/92. UGA Agriculture/Biotechnology, "Engineering insect resistance in soybeans". \$58,000.
 11/1/90-10/31/91. Crop Genetics International, "Analysis of insecticidal proteins in a biopesticide". \$20,000.
 1990-1991. UGA and GACCP, "Cell culture techniques for peanut improvement". \$68,000.
 11/1/89-10/31/91. Agrigenetics Co., "Assembly of an improved anti-coleopteran toxin gene. Analysis of *Bt* protein in cotton plants". \$200,798.
 7/1/89-6/30/91. UGA Agriculture/Biotechnology, "Characterization of *Bacillus thuringiensis* receptors in *Heliothis*". \$54,000.
 Summer 1989. "Evaluation of nematode-suppressive bacteria in cotton field tests," \$1,500.

D. Recognitions and outstanding achievements

Inventor Award, University of Georgia, 2006
 Featured scientist in University of Georgia "Scholars to Dollars" video, 2005
 Georgia Life Sciences Summit; Inventor Presentation, 2004
 C.V. Riley Lecturer, University of Missouri, 2004
 Invited visit to Beijing, China, supported by the National Natural Science Foundation of China and the International Agriculture program of the University of Georgia. 2001
 Seminar at Peking University
 Seminar at Chinese National Academy of Sciences
 Seminar at Chinese Academy of Agricultural Sciences
 USDA Biotechnology Risk Assessment Steering Committee (appointed 1999)
 Member Biotechnology Scoping Committee of the Council for Agricultural Science and Technology, 1997
 Co-organizer, Pacific Rim Conference on the Biotechnology of *Bacillus thuringiensis*. Chiang Mai, Thailand, 1996
 Mycogen Plants Sciences award for U.S. Patent covering "Synthetic *Bt* Genes." Cash award (\$10,000) and plaque, 1995
 Meeting Site Selection Committee of the Society for Invertebrate Pathology, 1994-2002.
 Co-organizer, Pacific Rim Conference on the Biotechnology of *Bacillus thuringiensis*. Taipei, Taiwan. October 1994.
 H.O. Lund Club Outstanding Teaching Award, 1993

Memberships

American Association for the Advancement of Science
 American Chemical Society
 American Society for Microbiology
 Entomological Society of America
 Georgia Entomological Society
 Society for Invertebrate Pathology

E. Area in which research is conducted

The overall goal in the laboratory is to conduct research that promotes the long-term usage of *Bacillus thuringiensis* insecticidal proteins. One project focuses on characterizing the interaction between *Bt* toxins and insect midguts. This is important in modifying *Bt* genes for improved insect control and for determining mechanisms by which insects acquire resistance in insects to *Bt* toxins.

F. Editorial Service

Editorial Board, *Biocontrol Science and Technology*, 2001-present
Editorial Board, *Pesticide Biochemistry and Physiology*, 1998-present
Editorial Board, *Applied and Environmental Microbiology*, 1995-2003

G. Convention papers

1. International Invitational Papers

Society for Invertebrate Pathology, Wuhan, China, Jurat-Fuentes and Adang, invited symposium lecture, 2006

1. International Invitational Papers, continued

IUPAC International Congress of Pesticide Chemistry, Kobe, Japan, invited symposium lecture, 2006

Society for Invertebrate Pathology Annual Meeting, Anchorage, Alaska, invited symposium lecture, 2005

Society for Invertebrate Pathology Annual Meeting, Burlington, VT, 2 invited symposium lectures, 2003

International Plant Resistance to Insects Workshop, Baltimore, MD, 2002.

Regional biopesticide symposium 16-18 October, Mahidol University, Bangkok, Thailand (2 invited symposium lectures). 2001

Keystone Symposium, Genetic Manipulation of Insects, Taos, New Mexico, 2001.

Society for Invertebrate Pathology, XXXIII Annual Meeting, Guanauato, Mexico, 2000.

VIIth International Colloquium on Invertebrate Pathology and Microbial Control and IVth International Conference on *Bacillus thuringiensis*. Sapporo, Japan, 1998.

Society for Invertebrate Pathology Annual Meeting-Banff, Canada, 1997

Second Pacific Rim Conference on *Bacillus thuringiensis*, Chiang Mai, Thailand, 1996

Society for Invertebrate Pathology Annual Meeting-Cordoba, Spain, 1996

Keystone Symposium, Towards the Genetic Manipulation of Insects, Tamarron, Colorado, 1995

Biotechnologia Habana. Havana, Cuba, November, 1995

Biofor Conference, Canadian National Conference on Forest Biotechnology, Montreal and Vancouver Canada, 1994

U.S.-Japan Conference on Biocontrol, Kyoto, Japan, 1994

Pacific Rim Conference on the Biotechnology of *Bacillus thuringiensis*, Taipei, Taiwan, 1994

VIth International Colloquium on Invertebrate Pathology and IInd International Conference on *Bacillus thuringiensis*. Plenary speaker for combined session, Montpelier, France, 1994

International Symposium on Recent Trends in Life Sciences, Hyderabad, India, 1993

World Congress on Cell and Tissue Culture. Second National Congress on Plant Biotechnology, 1992

Potential Ecological and Nontarget Effects of Transgenic Plant Gene Products on Agriculture, Silviculture, and Natural Ecosystems, Washington, DC. Sponsored by U.S.EPA, AgCanada and The Joyce Foundation. Invited Speaker and Panel Chair, 1992

Roussel Uclaf Round Table on Biopesticides, Paris, France, 1991

1st International Conference on Molecular Biology of *Bt*, San Francisco, CA, 1991

Second National Congress on Plant Biotechnology, Bogota, Columbia, 1991

Biotechnology Conference, Biological Pesticides, and Novel Plant-Pest Resistance for Insect Pest Management, Cornell University, Ithaca, New York, 1988

- International Congress of Entomology, Vancouver, Canada, 1988
 U.S.-Japan Conference on Biotechnology in Invertebrate Pathology and Cell Culture,
 Honolulu, Hawaii, 1986
 Fourth International Colloquium of Invertebrate Pathology, Veldhoven, Netherlands (two
 symposia lectures), 1986.
- 2. International Contributed Papers**
 5th International Symposium on Molecular Insect Science, Tucson, AZ (2 posters)
 Society for Invertebrate Pathology Annual Meeting, Anchorage, (3 posters, 1 presentation)
 Alaska 2005
 Glycobiology, San Diego (1 student poster), 2003
 Society for Invertebrate Pathology Annual Meeting, Burlington, VT, (3 student posters), 2003.
 Society for Invertebrate Pathology 34th Annual Meeting, Noorwijkerhout, The Netherlands (2
 student papers), 2001
 Society for Invertebrate Pathology Annual Meeting-Banff, Canada (3 student papers), 1997
 Third International Colloquium of Invertebrate Pathology, Brighton, U.K., 1982
- 3. National Invitational Papers**
 American Chemical Society Agrochemicals Special Conference VI "Molecular Genetics and
 Ecology of Pesticide Resistance, Big Sky, Montana, 1995
 Society for Nematology, Little Rock, Arkansas, 1995
 American Chemical Society, 1994
 Society for Invertebrate Pathology, Organized symposium-Mode of Action of *Bt* Toxins,
 (symposium lecture), 1993
 Society for Industrial Microbiology, Annual Meeting, Chicago, Illinois, 1988
 American Association for the Advancement of Science, Annual Meeting, Boston,
 Massachusetts, 1988
 Gordon Conference on Agricultural Sciences, Santa Barbara, California, 1987
 DuPont-UCLA Symposium on Molecular Strategies for Crop Protection, Steamboat Springs,
 Colorado, 1986
 Entomological Society of America, Annual Meeting 1984, 1988, 1989, 1991, 1993
- 4. National Contributed Papers**
 Entomological Society of America Annual Meeting, Salt Lake City, UT (1 student poster)
 Entomological Society of America, Annual Meeting, Cincinnati, OH (2 posters), 2003
 Entomological Society of America, Annual Meeting, Ft. Lauderdale, FL (1 paper, 2 posters),
 2002.
 Entomological Society of America, Annual Meeting, San Diego, CA (5 papers), 2001
 Society for Invertebrate Pathology, 1993, co-author on student papers 3, 1999.
 Entomological Society of America, New Orleans, LA, 1990; Reno, NV 1991 co-author on two
 student papers and one student poster; 1994, co-author on student paper; 1999 co-author
 on student paper
- 5. National Meetings Attended Without Presentations**
 U.S. Biotechnology Symposium, Washington, DC. 1998
- 6. Regional Invitational Papers**
 Southeast Vegetable Growers Meeting, 1995
 Georgia Entomological Society, co-author on student paper, 1994
 Entomological Society of America, Southeastern Branch, 1993
 Entomological Society of America, North Central Branch, 1993
 Capitol Area Tissue Culture Society, 1993
 Entomological Society of America, Southeastern Branch, 1992, co-author on 2 student papers
 SRIEG-*Heliothis* (Southern Region Information Exchange Group), 1990
 Ohio State University, 1989

Current and Future Trends in the Biological Control of Insects, Symposium, University of Wisconsin, Madison, 1988
 Southern Corn Improvement Conference, Atlanta, Georgia, 1988
 Entomological Society of America, North Central Branch, Des Moines, Iowa, 1987
 Advances in Agricultural Biotechnology, Symposium, University of Wisconsin, Madison, 1987

7. Special Meetings (Workshops, etc.)

USDA-Mexico Workshop on Insect Bt resistance workshop, 2004
 USDA/CSRS Workshop on *Bt* Resistance Management, 1992
 Symposium: Management Strategies for *Bacillus thuringiensis*-Based Products, Monsanto Agricultural Company, 1990
 U.S. Environmental Protection Agency Workshop, 1990
 U.S. EPA Conference on Pesticidal Transgenic Plants, 1990
 U.S. Congress Office of Technology Assessment Workshop, 1990

8. Seminars Presented

University of Kentucky, Dept. of Entomology, 2006
 Iowa State University, Dept. of Entomology, 2005
 University of Missouri, Dept. of Entomology, 2004
 Kansas State University, Dept. of Entomology, 2003
 Ohio State University, Dept. of Entomology, 2003
 University of Georgia, Dept. of Cellular Biology, 2003
 Verdia, Inc., 2003
 DOW Agrosiences, Indianapolis, IN, 2002.
 University of Montreal, Montreal, Canada, 2002.
 University of Georgia, Dept. of Plant Pathology, 1998.
 University of Georgia, Dept. of Biochemistry and Molecular Biology, 1996.
 University of Massachusetts - Amherst, Depts. of Entomology and Microbiology, 1995.
 University of Georgia, Dept. of Entomology, 1994
 University of Notre Dame, Dept. of Biological Sciences, 1994
 University of Georgia, Dept. of Horticulture, 1994
 University of Georgia, Dept. of Agronomy, 1992
 USDA Insect Attractants, Behavior and Basic Biology Laboratory, Gainesville, FL, 1992
 University of Georgia, Dept. of Microbiology, 1992
 North Carolina State University, Dept. of Entomology, 1992
 USDA Insect Management Laboratory (Tifton, GA), 1992
 Entotech, 1992
 Calgene, 1992
 Ecogen, 1991, 1993
 University of Tennessee, 1991
 University of Georgia, 1991
 DOW-ELANCO, 1991
 Crop Genetics International, Inc., 1990
 Clemson University, 1990
 Michigan State University, 1988
 University of Wisconsin, 1987
 Boyce Thompson Institute (Cornell University), 1986
 Mycogen Plant Sciences, 1993
 Ciba-Geigy, 1993
 Pioneer International, 1993
 University of Maryland, 1993

PUBLIC AND UNIVERSITY SERVICE

A. Public Service

1. Manuscripts reviewed for journals/grants for agencies (partial listing)

Annals Entomol. Soc. America
Applied and Environmental Microbiology
Arch. Insect Biochem
Biochemistry
Biological Control
Comparative Biochemistry and Physiology
GENE
Insect Molecular Biology
Journal for Invertebrate Pathology
Journal of Chemical Ecology
Journal of Agricultural Entomology
Journal of the American Society for Horticultural Science
Journal of Biological Chemistry
Journal of Wildlife Diseases
Microbiology
Molecular Breeding
Molecular Ecology
Nature Biotechnology
Proc. National Academy Sciences
Science

Grants reviewed (partial listing)

National Institutes of Health, Tropical Medicine and Parasitology Study Section Member, 1999, 2001
Nebraska Research Initiative Grants Program, Adhoc reviewer, 1998 (2)
North Central Plant Biotechnology, Panel Member, 1996-1997
University of Georgia Biotechnology Program, Panel Member, 1996, 1998
Ad Hoc reviewer, National Institutes of Health, 1994
National Research Council (U.S. - Mexico Foundation of Science), 1993
Reviewer, Midwest Biotechnology Consortium, 1992 (6)
The Consortium for Plant Biotechnology Research, 2004 (1), 2005 (2).
USDA/CSRS NRI Competitive Grants. Panel Member, 1992, 1993, 1996, 1999, 2005, 2006
Ad Hoc reviewer for USDA Grants Program, approximately 2 per year

2. Consulting

Mycogen Plant Sciences (formerly Agrigenetics Co.), 1988-1999.
Crop Genetics International, 1990-1994
Greenlee and Associates, 1990-1994
Hambricht & Quist, 1990-1994
EPA regarding transgenic plants, 1990-1994
USDA/APHIS regarding transgenic plants, 1991-1994
Arnall, Golden and Gregory LLP, 2000-2001.
DOW Agrosciences, 1999-present. Matters relating to Adang Bt plant patents.
Kaye Scholer, LLP. 2003-2004.
Mallesons, Stephens and Jaques (Australia) 2003-present.
Verdia, Inc. 2003-2004.
InsectiGen, Inc., 2004-present

B. Administrative service to the University

1. University committees

Charter Lecture Committee, 2002-2004
University Level Promotion and Tenure Committee (2000-2002). Chair 2002.
Program Review, Department of Pathology, Chair, 1999
Campus-wide Committee for Biotechnology Education, 1994-1997
University Council, elected Spring 1994 (term 1994/95-1997/98)
University Biosafety Committee (1993-2005)

2. College Committees

Co-organizer of 1st Agricultural Biotechnology Media Day, University of Georgia, 2001.
Biotechnology Liaison for CAES (2000-present)
Applied Biotechnology Degree Program Committee, (2000-present)
College of Agricultural and Environmental Sciences, D.W. Brooks Award Committee, 1999.
College of Agricultural and Environmental Sciences Scholarship Committee, 1993-1994
Advisory Committee for the Center for Soybean Improvement; Annual Meeting, 1992
Junior Faculty Advisory Committee-College of Agriculture, 1991

3. Division Committees

Steering Committee for Microbiology Training Grant, 1994-1998
Organizing Committee for "Center for Soybean Improvement" Annual Meeting, 1993
Steering Committee for the Molecular Parasitology Training Grant, 1992-1998

4. Department Committees

Search Committee for Molecular Entomologist (2001, Chair)
Executive Committee 1996
Search committee for vegetable entomologist, 1995
Search committee for medical entomologist, 1994
Chairman of search committee for temporary instructor of medical entomology, 1994
Coordinator of departmental seminars, September 1994-1995
Search committee for insect physiologist, 1994
Student paper rehearsals, 1990-1992
Entomology Graduate Student Progress Committee 1990, 1996-1999 (chair 1998-1999)

C. Other university and non-university activities

Faculty mentor for Eric Stabb, Assistant Professor, Microbiology, 2002-2004.
Biotechnology Award (presented at the Georgia Science and Engineering Fair) Originator and Presenter, 2000-2001.
Judge Georgia Science and Engineering Fair, 1998 - 2001.
Judge in the Athens-Clarke County High School Science and Engineering Fair, 1997, 1998
Mentor for students in the Georgia Science and Engineering Fair, 1997, 1998, 1999.
Review of bacterial bio-pesticides program for Forest Pest Management Institute, Sault Sainte Marie, Canada. 1994
Franklin College Outreach Program, 1993-present (about 2 presentations per year).
"Science-By-Mail" participating scientist with groups of elementary school students in Georgia and Alabama, 1993-1996